The Analysis of Verbal Behavior 1993, 11, 117-133

Teaching Topography-Based and Selection-Based Verbal Behavior to Developmentally Disabled Individuals: Some Considerations

Esther Shafer
The Central School of Speech and Drama
London, England

Augmentative and alternative communication systems are widely recommended for nonvocal developmentally disabled individuals, with selection-based systems becoming increasingly popular. However, theoretical and experimental evidence suggests that topography-based communication systems are easier to learn. This paper discusses research relevant to the ease of acquisition of topography-based and selection-based systems. Additionally, current practices for choosing and designing communication systems are reviewed in order to investigate the extent to which links have been made with available theoretical and experimental knowledge. A stimulus equivalence model is proposed as a clearer direction for practitioners to follow when planning a communication training program. Suggestions for future research are also offered.

The use of augmentative and alternative communication systems for developmentally disabled persons who do not acquire speech represents a major advance in the treatment of this population. These systems include sign language or gesture, communication boards or books from which the user selects pictures or drawings, and more recently, electronic communication aids with voice synthesizers. Often, a combination of systems are recommended to meet varying needs of users (Calculator, 1988; Reichle, Mirenda, Locke, Piché, & Johnston, 1992; Rotholz, Berkowitz, & Burberry, 1989).

An important differentiation between sign language and symbol-based systems can be made according to their respective response forms. Michael (1985) has classified sign language as *topography-based* verbal behavior, and symbol-based systems as stimulus-selection based (or *selection-based*). In topography-based verbal behavior, the form of the response distinguishes one sign from another. For example, the sign *drink* is formed by a combination of movements and handshapes which is different from other signs. In selection-based verbal behavior, the form of the response remains the same for all verbal responses, and may consist of pointing to, touching, looking at, or indicating a stimulus in some other way. The stimuli that are selected, and resulting effects on listeners, are what distinguishes one verbal response from another. Pointing to a symbol of *drink* on a communication board involves the same response form as pointing to any other symbol, but will result in a different response from listeners than pointing to a symbol of *hamburger*.

Although both topography-based and selection-based systems are widely used, selection-based systems have been increasingly prescribed in recent years for persons with severe developmental disabilities (Locke & Mirenda, 1988; Mirenda, 1985; Mirenda & Santogrossi, 1985). However, the bases upon which decisions are made to recommend all communication systems require closer scrutiny. Reichle, Sigafoos, and Remington (1991) have noted that choice of an augmentative communication

An earlier version of this paper was presented at the Annual Conference, Experimental Analysis of Behaviour Group, London, England, March 29-31, 1991. Reprints may be obtained from the author, 4 Oaklands, Constance Road, Whitton, Twickenham, Middlesex TW2 7JQ, England.

system and symbol selection technique is frequently based on personal preference and assumed knowledge, rather than data provided by the learner.

The selection of a communication system for a nonvocal individual has far-reaching implications. Since the acquisition of functional communication will have a profound impact on an individual's life and the training time required to develop a verbal repertoire is often extensive, a thorough understanding of the variables that contribute to the success of treatment procedures is needed.

This paper will investigate the extent to which links have been made between current communication training practices and available theoretical and experimental knowledge. First, theory and research relevant to the ease of acquisition of topography-based and selection-based systems will be discussed. Next, the decision-making process for recommending and designing communication systems will be examined in light of theory and research. Finally, suggestions will be proposed in order to make better decisions about the choice of a communication system, and for further research.

THEORY AND RESEARCH WHICH HAS RELEVANCE TO THE CHOICE OF A COMMUNICATION SYSTEM

Theoretical Indications That a Topography-Based System May Offer Advantages

In Michael's (1985) paper which distinguishes topography-based and selection-based verbal behavior, he cites several reasons why topography-based systems may offer advantages. First, selection-based verbal behavior requires a conditional discrimination in which a controlling variable (verbal stimulus, nonverbal stimulus, or establishing operation) alters the controlling strength of another stimulus over a nondistinctive response such as pointing or touching. For example, in the selection-based mand relation, an establishing operation which momentarily increases the effectiveness of liquids as a form of reinforcement alters the controlling strength of a symbol for "drink" over the response of touching or pointing to that symbol. In comparison, topography-based verbal behavior involves only one primary controlling variable. In the topography-based mand relation, the establishing operation directly controls the response of producing the sign for "drink." Because topography-based verbal behavior does not have the increased degree of conditionality of selection-based verbal behavior, Michael proposes that a topography-based repertoire is easier to acquire, control by motivative variables is more effective, and susceptibility to interference by similar functional relations is decreased.

Secondly, topography-based verbal behavior involves point-to-point correspondence between the response form and the response product, whereas selection-based verbal behavior does not. Point-to-point correspondence refers to the correspondence between the muscle action involved in producing the response and the relevant details of the stimuli which result. In speech the muscle action is of the vocal apparatus and results in an auditory stimulus for the listener, and in signing the muscle action is through the use of the hands and arms and the stimulus that is produced is visual. Michael suggests that point-to-point correspondence is another advantage of topography-based systems which results in the successful acquisition and maintenance of topography-based verbal relations.

And third, selection-based verbal behavior requires an effective scanning repertoire. If the set of verbal stimuli is reasonably large and the scanning repertoire is not systematic, the appropriate verbal stimulus may be overlooked. Also, if the scanning takes much time, the effectiveness of the nonverbal stimulus in a tact relation or the motivational variables in a mand relation may be lost by the time the appropriate verbal stimulus is encountered. With severely developmentally disabled individuals, one can reasonably assume that many have not developed the skills necessary to scan a large number of

pictures or symbols on a communication board.

Research Directly Comparing Topography-Based and Selection-Based Systems

Despite the important implications of whether topography-based verbal behavior has advantages over selection-based verbal behavior, few direct comparisons of the two systems have been attempted. Of those studies which have contrasted the two types of systems, the results lend support to Michael's (1985) proposal that topography-based verbal behavior has characteristics which result in greater ease of learning.

Two studies (Sundberg & Sundberg, 1990; Wraikat, Sundberg, & Michael, 1991) have compared topography-based and selection-based verbal behavior in terms of the ease of tact and intraverbal acquisition and the emergence of a new stimulus equivalence relation, a test for mand compliance. In the Sundberg and Sundberg study, both the topography-based tact and intraverbal relations were acquired more easily than the selection-based relations. On the test for mand compliance, the topography-based repertoire also showed advantages, although there was a great deal of variability among subjects in their overall level of achievement. Of four subjects, one easily demonstrated both relations, while another demonstrated the topography-based mand compliance relation but not the selection-based relation. Another subject demonstrated neither relation but came closer with the topography-based relation, while a fourth had never acquired the topography-based tact and could not be tested on the equivalence relation.

The Wraikat et al. study attempted to ensure that all subjects acquired the tact and intraverbal repertoires by adjusting the difficulty of the task depending upon the subject's performance during training. The results clearly favored the topography-based system with respect to ease of acquisition. All seven subjects reached criterion with the topography-based tact and intraverbal, whereas three did not reach criterion for the selection-based tact and four did not reach criterion for the selection-based intraverbal. Trials-to-criterion were generally fewer for topography-based than selection-based relations, although individual differences were evident. On the test for the mand compliance relation, six of the seven subjects performed correctly more often on the topography-based relation, while one subject did not achieve correct performance on either relation.

Hodges and Schwethelm (1984) in a study published in the *Applied Psycholinguistics* journal, compared the effectiveness of graphic symbol and manual sign training with 52 profoundly retarded children. One of their experiments investigated whether signs or symbols were easier to acquire when measured by length of time and number of trials required to reach criterion. The children were taught to request desired items that were in view, therefore a combination of a tact and mand contingency was in effect. Signing was found to be the most efficient in terms of number of single-word utterances (either sign or symbol) mastered and number of sessions required for mastery. Significantly, of 17 children who were unsuccessful in learning symbols, 12 were subsequently able to learn one or more signs.

Formation of Equivalence Relations in the Developmentally Disabled Population

Because conditional discriminations enter into equivalence class formation, the variables that affect the formation of stimulus equivalences with developmentally disabled persons are important to isolate. Several related areas of research can provide further understanding into the factors that might interfere with successful teaching of a communication system.

Formation of conditional discriminations. The acquisition of selection-based verbal behavior depends upon the learner's ability to form conditional discriminations, yet a number of studies have indicated that persons with developmental disabilities have difficulty in doing so (McIlvane, Dube, Klederas, Iennaco, & Stoddard,

1990). In fact, deficits in relational learning can be viewed as a defining characteristic of this population (Green, Mackay, McIlvane, Saunders, & Soraci, 1990).

Identity matching. An identity matching task is a conditional discrimination procedure in which the sample and the positive comparison are the same. Another term for identity matching is reflexivity, one of the prerequisites that must be satisfied before inferring that stimuli have become members of an equivalence class. Mackay (1991) observed that many developmentally disabled persons have not acquired the skill of generalized identity matching, a necessary skill for further learning of many complex behaviors. This view was supported by Keogh and Reichle (1985) who determined that without the ability to match objects to photographs or line drawings, little progress toward acquiring a symbolic communication system can be expected. They recommended that instruction in matching skills should precede the introduction of a selection-based system if the student is lacking in these skills.

Other investigators who attempted to teach a selection-based system observed a strong relationship between the subjects' identity matching abilities to successful completion of the experimental tasks. Romski, Sevcik, and Pate (1988), who used lexigrams to teach request-making when an item was in view, compared the matching skills of four subjects during a pre-assessment procedure. The subject whose identity matching skills were the least developed of the four was unable to learn to choose the lexigram which corresponded to a food item on display, and was eventually discontinued from participation in the study. The subject who displayed the most accurate matching skills during the pre-assessment procedures achieved the fewest number of trials to criterion on the experimental task.

Mirenda and Datillo (1987) also discussed the relationship between matching abilities of subjects and ability to learn to use a pictorial communication system to make requests. In their study, only one of three subjects who had well-developed matching abilities including identity matching using objects, matching objects to pictures, and matching objects to line drawings was able to learn to choose among five pictures to make spontaneous requests. The other two subjects with less well-developed matching skills did not acquire the desired responses. Although the subject with the best matching abilities did not score as well as another subject on a pre-assessment of her receptive language or mand compliance skills, the ability to identity match was apparently more important than mand compliance skills in learning to use the communication system.

Additionally, identity matching seems to be a skill that correlates with other aspects of verbal behavior. Sevcik and Romski (1986) assessed identity and non-identity matching for objects, photographs, and line drawings. Subjects who demonstrated some expressive language skills were better able to match on both identity and non-identity tasks than subjects with few developed expressive language skills. Romski et al. (1988) noted a similar pattern in their subject who was most successful in the experimental task. This subject had the most well-developed mand compliance repertoire of the other subjects and exhibited more vocal verbal behavior at the start of the experiment. Incidentally, by the end of the experiment, both repertoires had significantly increased.

While training procedures have been developed that have resulted in the establishment of conditional relations with developmentally disabled persons (e.g. McIlvane et al., 1990; Saunders & Spradlin, 1989, 1990; Zygmont, Lazar, Dube, & McIlvane, 1992), these require much time and specialized knowledge to implement. Perhaps for these reasons, Green et al. (1990) have noted that procedures such as these have not as yet been routinely incorporated into special education classrooms.

Stimulus overselectivity. When an individual characteristically responds to a restricted portion of environmental stimuli, this pattern is referred to as stimulus overselectivity (Cook, Anderson, & Rincover, 1982), or restricted stimulus control

(Stromer, McIlvane, Dube, & Mackay, 1993). Stimulus overselectivity has been described as one of the characteristics often found in individuals diagnosed as autistic and to some extent, in persons classified as developmentally delayed (Burke, 1991). Stimulus overselectivity can occur on conditional discrimination tasks that require responding on the basis of more than one component. The components could be from the same modality, such as a picture containing two elements, or from different modalities, such as a picture and a corresponding auditory stimulus (Cook et al., 1982).

Difficulties may arise in many kinds of teaching situations. For example, an individual may have learned to select a picture of a drink from an array of pictures when an actual drink is in view. Overselectivity is demonstrated if the individual responds on the basis of a restricted aspect of the original stimulus, such as the color, shape, or size of the container holding the drink. If another drink is substituted which looks very different from the drink used in training, the individual may not continue to select the picture of drink. Another aspect of overselectivity is frequently referred to as prompt dependency. For example, a student may have learned to sign *drink* when a drink is in view and when an imitative prompt from the teacher is presented. However, responding may have come under control of the imitative prompt, instead of the relevant motivative variables and/or the sight of the drink itself. A problem will occur in later trials if the prompt is not included, and as a result, the student will not produce the sign for *drink*.

The role of topography-based behavior in the acquisition of selection-based behavior. The role of naming in equivalence class formation has been widely studied, with the general consensus being that equivalence class formation does not require or depend on a naming process (Sidman, Willson-Morris, & Kirk, 1986; Lazar, Davis-Lang, & Sanchez, 1984). However, teaching differential responses in a naming procedure has been shown to facilitate equivalence class formation in persons with developmental disabilities. These responses have included button presses (Saunders & Spradlin, 1989), and spoken words or phrases (Saunders & Spradlin, 1990; Eikeseth & Smith, 1992). Of particular relevance to whether topography-based verbal behavior has advantages over selection-based verbal behavior is a study by Lowenkron (1988), who used differential motor responses in the form of handsigns to facilitate the development of delayed identity matching. In this study, four children with developmental disabilities were trained using an generalized delayed identity matching-to-sample procedure. They were first taught to use a particular handsign to tact a sample shape, to maintain the handsign over a delay interval, correctly tact one of the comparison stimuli without changing the current handsign, and then to select the comparison shape that allowed a repetition of the sample handsign. Before the handsigns were trained, little generalization of matching occurred, but after handsigns were taught, accurate generalized matching appeared. Lowenkron explained the process as one of joint control. In this experiment, the handsign topography was evoked by both the comparison and the sample stimulus in a tact relation, and subjects' maintenance of the handsign over the delay interval was described as a self-echoic. Therefore, reinforcement was contingent upon selecting the comparison permitting joint echoic-tact control.

Lowenkron (1991) proposed that topography-based behavior plays an essential role in the process of joint control and is therefore necessary for the generalization of selection-based behavior. In fact, Lowenkron stated that selection-based verbal behavior is dependent upon, rather than an alternative to topography-based verbal behavior. Aside from the example of joint echoic-tact control described in Lowenkron's 1988 experiment, there are other examples in which a naming response could facilitate acquisition of the desired behavior. For instance, in the case of a manded stimulus-selection in which the comparisons are visible, the sample is

verbal (find "cat") and the comparisons are non-verbal. The learner can provide a verbal sample by first making a topography-based intraverbal (the manual sign for "cat") to the auditory stimulus "cat," and then making a topography-based tact (the manual sign for "cat") to the comparisons. Reinforcement is now contingent upon selecting the comparison (picture or symbol of "cat"), thus permitting joint intraverbal-tact control. Lowenkron's proposal has significant implications in that providing developmentally disabled persons with a topography-based repertoire teaches behaviors that can enter into further equivalence relations, greatly expanding the potential for development of a number of new skills.

CONSIDERATIONS IN CHOOSING COMMUNICATION SYSTEMS

As yet, decisions concerning choice of a communication system do not seem to be greatly influenced by the theory and research which favors topography-based systems. However, there is a sizeable body of literature offering strategies for choosing communication systems. Therefore, a closer look at this literature should provide insight into current communication training practices.

Reasons Why Selection-Based Systems are Recommended

There are a number of reasons cited in the literature as to why selection-based systems are thought to have advantages over topography based systems. These can be categorized in two ways: failure of topography-based systems to achieve the desired results, and advantages attributed to selection-based systems.

Failure of topography-based systems. A frequently cited reason for recommending a selection-based system is the failure of sign language training to achieve desired results. Yet, in many studies that have reported failure with topography-based systems, it is apparent that effective methods and procedures were not used in training (Sundberg, 1990). In order to successfully teach a topography-based system, a number of factors must be taken into account. Much of the success of training depends upon the skills of trainers, including the ability to shape and prompt motor responses so that prompt dependency does not occur. Another consideration which is often overlooked involves the arrangement of contingencies which facilitate transfer of stimulus control across verbal operants. A number of studies (e.g., Hall & Sundberg, 1987; Lamarre & Holland, 1985) have validated Skinner's (1957) analysis that different verbal operants are acquired independently, yet some language programs do not include procedures for transfer of stimulus control across verbal operants. In addition, procedures which are designed to facilitate maintenance and generalization must be an integral part of teaching a communication system. Suggestions such as the ones offered by Halle (1988) for adopting the natural environment as the context of training reflect a growing awareness of this need.

Most importantly, some training programs neglect the role of the mand in the development of a verbal repertoire. Skinner (1957) defined the mand "as a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of the relevant conditions of deprivation or aversive stimulation" (pp. 35-36). The mand is a type of verbal behavior that is controlled by motivational variables (i.e., establishing operations, or EOs), and should be a primary aspect of language training programs with the developmentally disabled (Michael, 1988).

There are many ways that EOs can be incorporated into mand training procedures. Using Michael's (1993) classification system of the different types of EOs, Sundberg (1993) described how EOs can either be captured as they naturally occur in the environment, or can be contrived. Capturing an EO involves taking advantage of occasions during which an EO is strong to conduct mand training, such as teaching the sign *drink* when the individual is naturally thirsty. Contriving an EO requires the manipulation of some object

or event that alters the value of another object or event as a form of reinforcement. For example, a number of studies have utilized a procedure in which an essential item for completing a chain of behavior is not easily accessible, establishing the missing item as a form of reinforcement (Alwell, Hunt, Goetz, & Sailor, 1989; Hall & Sundberg, 1987; Romer & Schoenberg, 1991). While the growing emphasis on developing mand training procedures is encouraging, there are still many applications to be explored.

Advantages attributed to selection-based systems. Several advantages commonly attributed to selection-based systems are summarized by Wraikat et al. (1991). Most selection-based systems require the user to point to pictures if physically able, and pointing may seem to be a simpler skill to master than signing. Sign language involves acquiring a repertoire of complex motor skills, whereas the relatively simple pointing response, or lacking that, a touching response is often already strong for many individuals. Since symbols provide a permanent display, this may seem to make the task easier, in that the user does not have to "remember" a large number of signs. And finally, a symbol chart is often made easy for listeners to use. If symbols are not easily identifiable, the corresponding words are usually written under them. Use of a selection-based system also frees the listener from learning sign language.

In addition, selection-based systems are sometimes cited as being more appropriate for students who display a certain set of characteristics or skills. Mirenda (1985) explained that some students, many of whom are described as autistic, have relatively good visual discrimination skills but experience difficulty processing auditory information. These students may also show difficulty in coding temporal, transient information, which is said to account for their failure to acquire sign language. Locke and Mirenda (1988) suggested that selection-based systems may be more appropriate for students who have limited visual discrimination skills, along with the additional difficulties of reduced precision of motor control and limited ability to code temporal information. Mirenda recommended symbol systems of a concrete nature, such as pictures and photographs, while Locke and Mirenda recommended the use of communication devices that produce synthesized speech, in order to provide feedback for users as well as output to listeners.

The recommendations offered in these two papers leave many questions unanswered. Selection-based systems have been recommended for individuals with both good and poor visual skills, and the practitioner is left to make judgements about how to match the features of the communication system to the characteristics of the individual. Additionally, the task of determining whether a student has difficulty processing auditory information, and the means by which to evaluate a student's ability to code temporal, transient information is not explained.

Reasons Why Topography-Based Systems Are Recommended

Several reasons are frequently cited as to why topography-based systems should be recommended. These include the practical advantages of topography-based systems, iconicity, and research which indicates that sign language will assist the development of vocal verbal behavior.

Practical advantages of topography-based systems. Because selection-based systems involve some sort of auxiliary equipment, the practical advantages of topography-based systems become apparent. Communication boards, books, or electronic communication aids must either be continually carried by the user or remain accessible. They may get lost, break down, require frequent updating, and can be expensive when electronic communication aids must be purchased. Some additional problems may need to be overcome if a large number of symbols are to be included. Many concepts other than nouns are difficult to portray with a symbol except in an abstract manner, and the system may become unwieldy or complicated.

Iconicity. An iconic sign is one whose shape or movement pattern shares some features of the corresponding object or action. Iconicity is often said to be a feature of signing that contributes to the ease of learning (Light, Remington, Clarke, & Watson, 1989).

DePaul and Yoder (1986) have described two components of iconicity: transparency and translucency. Signs are usually categorized as transparent or translucent depending upon the guessability of the sign when shown to persons unfamiliar with sign language. For example, the sign *baby* demonstrates the crtieria for transparency, because the movements of the sign resemble holding and rocking a baby and is usually guessed correctly. The sign *vote* is an example of a translucent sign. Even though the movements and handshapes resemble putting a ballot in a box, these movements resemble other actions as well, and the sign is not usually identified as *vote* without additional cues.

The precise role that iconicity plays in acquiring a topography-based repertoire has been examined further by Doherty (1985), in a review of sign characteristics on acquisition. Generally, developmentally disabled persons learn to produce iconic signs more rapidly than noniconic signs. Also, signs with greater degrees of iconicity, or transparency, are acquired more easily than less iconic, or translucent signs. The benefits of iconicity in acquiring a topography-based repertoire may vary depending on the individual's overall degree of language skills (DePaul & Yoder, 1986) and severity of handicap (Doherty, 1985). Doherty observed that when studies failed to show an advantage for iconic signs over noniconic signs, the subjects tended to be more limited in terms of their overall level of functioning.

The facilitation of vocal verbal behavior. Sundberg (1990) has offered several reasons why sign language improves speech. First, acquiring a sign language repertoire allows many nonvocal individuals to come into contact with the reinforcers for successful verbal behavior for the first time. The motivation to communicate in general will increase, and so may the motivation to speak. Second, increasing the overall frequency of communication allows increased opportunities to shape vocal behavior. Third, the components of signs can sometimes be used as prompts to improve speech articulation. Signing requires the sequencing of motor movements as does speech, and the components of words can often be matched to the components of signs.

There is evidence to suggest that topography-based behavior facilitates the acquisition of vocal behavior only when the individual has some degree of skill in vocal imitation (Clarke, Remington, & Light, 1988; Kouri, 1989; Yoder & Layton, 1988). In the Kouri study, the subject entered with some vocal imitative skills and a vocabulary of eight word approximations. Training extended over an eight-month period, in which total communication (simultaneous speech and signing) was provided. Over the course of training, 192 different words were spoken, and more than half of these words had been initially signed. In both the Clarke et al. and Yoder and Layton studies, subjects varied in terms of the vocal imitation skills they displayed at the start of training. When speech acquisition after total communication training was examined, only those subjects who had preexisting vocal imitation skills showed increases in speech.

Recommending Multi-Modal Communication Systems

In recent years, there has been a growing importance placed upon the teaching of multiple forms of communication. This approach differs from the practice of choosing one system from the outset of training with the intention of making it the individual's primary communication system (Calculator, 1988; Reichle et al., 1992). A multi-modal system may include some combination of a topography-based and selection-based system. Additionally, the term is often used when communicative forms such as gesture or eye gaze are encouraged in conjunction with another communication system.

Several suggestions have been offered for the implementation of multi-modal communication systems. One suggestion is to teach both a topography-based and selection-based system to learners who are just beginning to acquire a verbal repertoire. This approach is said to allow the learner to use his or her best communication mode from the outset and to make it possible for the practitioner to observe which is most successful over time (Reichle et al., 1992). Another example of establishing multimodal communication is to teach a selection-based system for use in certain situations after the learner already has acquired some skill in a topography-based system. The advantage attributed to this approach is that selection-based systems are easier for unfamiliar listeners to interpret, and will be a more effective form of communication in community settings such as restaurants (Rotholz et al., 1989). The strategy is also recommended for individuals whose signs are poorly articulated. A third recommendation concerns individuals who already have a repertoire of other response forms such as gesture, eye contact, and facial expression that listeners respond to. The point has been made that these communicative responses should not be ignored just because an augmentative communication system has been implemented (Beukelman, 1987; Calculator, 1988), since normal speakers use a variety of modes of communication in different circumstances.

The reasons offered for recommending multiple communication systems of communication are varied, and each deserves closer consideration. In particular, the requirements of subjects who have little or no effective communication and subjects who are learning a second system of communication should be examined more closely.

When multiple systems are recommended from the outset, this offers the opportunity to empirically determine which system will ultimately be successful. However, this approach would seem to be preferable only if there is no other empirical basis upon which to choose a communication system. Instead, the inherent benefits and drawbacks of each system could be considered, as could the skills of the individual that are likely to lead to success with a particular system.

A different set of circumstances exists when individuals are acquiring a second communication system. In two studies that have reported success with this approach (Hooper, Connell, & Flett, 1987; Rotholz et al., 1989), subjects already had a topography-based repertoire of verbal behavior before the selection-based system was introduced. In the Hooper et al. study, the subject had "a well-developed idiosyncratic gesture system for basic needs" (p. 69). The Rotholz et al. study included two subjects; one subject was reported to have functional use of approximately 35 to 40 signs, while the other subject had functional use of approximately 12 signs. The facilitative effect that the subjects' topography-based verbal behavior may have had upon their acquisition of a selection-based system should not be overlooked.

The caution not to ignore effective means of communication such as gestures or eye gaze just because another communication system is being taught is an important one. In a survey of research which investigated interaction patterns of users of selection-based systems, Light (1988) found that nonspeaking individuals tend to rely on forms of communication such as eye gaze or gesture more frequently than their communication boards or electronic communication aids. With developmentally disabled persons whose overall frequency of initiating communication may be somewhat limited, the importance of responding to appropriate verbal behavior in any form should be stressed. Any communicative behavior which results in reinforcement is likely to increase the total opportunities for interaction and therefore opportunities to shape and reinforce other response forms.

CONSIDERATIONS IN DESIGNING COMMUNICATION SYSTEMS

Once a communication system has been chosen, there are still many decisions to be made concerning the design of specific fea-

tures of the system. Recommendations for designing both topography-based and selection-based communication systems have been widely presented in recent years (e.g. Duker & Remington, 1991; Mirenda & Santogrossi, 1985; Reichle et al., 1991). A review of some of these recommendations for communication system design will describe the many factors that must be considered in order for the system to be successful.

Designing Selection-Based Systems

Choice of visual stimuli. The choice of visual stimuli is an important factor in determining the user's success with a selection-based system. A number of commercial symbol systems are available and range from pictures that are iconic, sharing many of the stimulus features of the actual object or event, to symbols which have few or none of the stimulus features of the items they are to depict. In addition, picture systems can be constructed from photographs, magazine pictures, food labels and other similar sources (Mirenda, 1985).

Iconicity is often attributed to be a relevant factor contributing to the ease of acquisition of selection-based systems, particularly for individuals who are beginning to use a communication system. Mirenda's (1985) recommendation to find pictures from a variety of commonly available sources rather than use commercial symbol sets is based upon this premise. Empirical evidence also favors iconic picture systems over more abstract systems in terms of acquisition, generalization, and frequency of spontaneous usage (e.g., Hurlbut, Iwata, & Green, 1982).

However, the use of symbols having a substantial amount of iconicity such as photographs does not guarantee acquisition of a selection-based system for all individuals. In a particularly relevant study, Dixon (1981) assessed photograph-to-object and object-to-photograph matching skills with developmentally disabled subjects. She found that some subjects failed to develop the skill because they were apparently only attending to the depth properties of the objects and photographs. The photographs were flat and rectangular, while objects had other depth dimensions. When photographs were cut out so that the edge shape of the photograph and object matched, subjects were better able to match photos and objects. Even though the subjects were able to match photos and objects successfully under these conditions, they would still need to acquire additional skills for generalized matching to occur. Romski and Sevcik (1988) and Sevcik, Romski, and Wilkinson (1991) have suggested that the relative difficulty of various types of symbol systems cannot be prejudged, but must be determined separately for each individual.

Arrangement of visual stimuli. The placement of multiple visual stimuli on a communication board or in a communication book is an additional factor that must be carefully considered. Mirenda (1985) suggested some forms of communication systems which are designed to circumvent potential problems, but which may actually create additional complexities. Picture books can be designed with one picture on the page to avoid scanning requirements, but this arrangement can be a cumbersome and time-consuming method if there are many pages to search through. A long latency between the presentation of the stimulus and the occurrence of the response may be created, thereby weakening the verbal relation by delaying the delivery of consequences. For individuals who have a fairly well-developed scanning repertoire, Mirenda recommended that pictures be grouped by categories or on different colored pages. Despite the potential advantages, this type of design adds an additional element of abstractness into the system, requiring the user to respond first to color and then picture. In general, Mirenda suggested that one must undergo somewhat of a system of trial and error in order to find the best arrangement for each individual.

Designing Topography-Based Systems

The first consideration in choosing a sign to teach should always be whether production of that sign will provide the learner

with frequent opportunities for reinforcement, or in other words, is functional for the learner. However, if there are several signs that are judged to be equally good choices for training on this basis, then several other factors can be considered. These include motoric skills of learners, and iconicity.

Motoric skills of learners. If an individual has difficulty in producing signs so that others can react accurately to them, the effectiveness of the resulting communication may be substantially lessened. Signs can vary greatly in terms of the movement patterns and handshapes that are required. Doherty (1985) has named seven dimensions by which signs can vary. These are: (a) contact between hands or with the body, (b) symmetry of movement, (c) whether one or both hands are used, (d) visibility of the movement by the signer, (e) repetition or duplication of movement, (f) number of distinct movements, and (g) number of handshapes.

The benefits of conducting a motoric skill assessment before selecting signs for teaching have been discussed by Dennis, Reichle, Williams, and Vogelsberg (1982). They recommend that two areas be directly assessed: prehension patterns, or the ability to produce handshapes and positions of fingers, hands, and forearms; and unilateral/bilateral hand use, meaning the use of the hands individually or in combination relative to the midline of the body. Dennis et al. also recommend that a third factor referred to as motor planning be considered. Motor planning includes skills that contribute to the fluent production of signs, such as the movement of fingers and hands in relation to each other and the body, plus combinations and sequences of movement. These authors note that individuals often can produce individual movements or handshapes, but may not be able to combine them into smoothly flowing sequences.

The information gained from a motoric skills assessment can be used to match motor abilities of the learner to the requirements of particular signs. Doherty (1985) has recommended that certain kinds of signs will be easier to produce than others. These include signs that involve contact with the hands or body and signs whose movements are symmetric. However, sign training should not be delayed because an individual cannot execute motor movements fluently. Young deaf children who are first learning to sign usually only make sign approximations (McEwen & Lloyd, 1990), and motoric movements are likely to improve with practice as the individual acquires a larger sign repertoire (Dennis et al., 1982). The situation may also exist in which a sign would be highly functional for a learner but the learner cannot execute the motor patterns proficiently. In such cases, the functionality of the sign should outweigh other factors (Dennis et al., 1982).

Motor imitation is a related subset of skills that greatly facilitates the acquisition of topography-based verbal behavior. An individual who can imitate motor movements can easily be prompted to produce signs under a variety of conditions. The absence of a strong imitative repertoire does not preclude the teaching of signs, but progress will be slower. Sundberg (1990) has developed an assessment which can be used to assess the extent of an individual's imitative skills.

Iconicity. Because the literature indicates that iconicity can influence the ease of acquisition of a topography-based repertoire, signs with a high degree of iconicity should be taught whenever possible. The knowledge regarding both motoric requirements and iconicity can be taken into account when choosing signs for training. Doherty (1985) has recommended that highly translucent, one-handed contact signs should be included among the first five signs taught. The sign *eat* is an example of such a sign, which also meets the criterion of being highly functional, since production of the sign could potentially lead to frequent opportunities for reinforcement throughout the day. After an individual has learned approximately five signs, Doherty recommends that a logical next step would be to include symmetric, two-handed contact signs with a high degree of iconicity. Another benefit of teaching

iconic signs is that they are often guessable by others, making it more likely that production of the sign will lead to reinforcement.

THE RELEVANCE OF PREREQUISITE SKILLS IN RECOMMENDING A COMMUNICATION SYSTEM

A significant shift in thinking about the role of prerequisite skills in recommending a communication system has occurred in recent years. One important benefit has been that more developmentally disabled persons are receiving communication training, and in many cases these interventions are better tailored to their individual needs and abilities.

A traditional approach to recommending a communication system was to offer training only if the person had reached a specified cognitive level. One set of guidelines was proposed by Owens and House (1984) who used a decision-making model based on Piagetian theory. They recommended that if a person does not have the skills present in Sensorimotor Stage five, generally acquired at age 11-14 months, then skills generally classified as cognitive, social, and receptive should be taught as prerequisites for augmentative communication training. Examples of specific skills recommended for teaching by Owens and House include means-ends, motor imitation, object permanence, causality, symbolic play, and functional use.

The view that levels of cognitive functioning should be used to exclude persons from augmentative communication training sparked a strong reaction and is represented in a paper by Kangas and Lloyd (1988), who argued against this approach to making treatment decisions. These authors observed that there have been a number of individuals who have attained higher levels of functional communication than would be predicted from their measured levels of cognitive development. Kangas and Lloyd's interpretations of what falls under the rubric of augmentative and alternative communication are broad, and their treatment suggestions are at a basic level. For example, their recommendations include the teaching of one symbol or sign to be used as a generalized "want" in order to make a number of requests, teaching a person to indicate protest or rejection by pushing away an unwanted object, and increasing the person's response to touch cues. These authors were careful to suggest that the individual may not necessarily "understand" the meaning of the message being conveyed, or presumably, has not learned to behave differently in response to different verbal stimuli. For instance, if the person learns to access a switch-operated device that activates a tape loop with a recorded message ("help me, please"), assistance can be provided by a listener. The behavior of activating the device is maintained by the consequences that follow, and the form of the recorded message may be irrelevant for the user. Finally, Kangas and Lloyd did not suggest that acquisition of the skills they recommended will necessarily lead to development of a more extensive verbal repertoire.

The Role of Preverbal, Prelinguistic, Presymbolic, or Nonsymbolic Communication

The recommendations of Kangas and Lloyd parallel an increased recognition of a subset of communicative behaviors often referred to as preverbal communication (Butterfield, 1991), prelinguistic communication (Ogletree, Wetherby, & Westling, 1992), presymbolic communication (Rowland & Stremel-Campbell, 1987), or nonsymbolic communication (Siegel-Causey & Guess, 1989). The types of skills recommended by these authors include many of the prerequisite skills recommended by Owens and House (1984), with an emphasis on response forms other than speech such as eye contact, gestures, and undifferentiated vocalizations. The primary consideration, however, is not the form of the response but the communicative function of the behavior. From this perspective, preverbal behaviors are often said to regulate the behavior of others, engage others in social interaction, and reference joint attention (Ogletree et al., 1992). Because many individuals are not immediately successful

in acquiring speech or a communication system such as sign language or a symbol board, the development of preverbal communicative skills is increasingly becoming the focus of training programs (Butterfield, 1991). Aside from providing students with goals that are more easily achieved, there is a growing acceptance that acquisition of these skills may be prerequisites for further communication training (Reichle et al., 1991).

This dual purpose of providing learners with achievable goals while at the same time teaching important prerequisites for further communication training can be illustrated with the Picture-Exchange Communication System or PECS (Bondy & Frost, 1993). The PECS differs from the majority of selection-based systems because the user is taught to hand a picture to another person instead of pointing to the picture. A mand repertoire is developed, based on a preliminary identification of objects that serve a reinforcing function for each user. The primary application of the PECS has been with young autistic children, who often display a relative insensitivity to social reinforcers and have difficulty orienting and attending to visual stimuli, two sets of skills which contribute to the success of learning to use most augmentative communication systems. The PECS also initially bypasses the need to have a strong imitative repertoire, a factor that is relevant to success with a topography-based system. An additional advantage of the PECS might be to concurrently develop interaction skills with others. Butterfield (1991) noted that a significant milestone in the development of an individual's communication is to involve others in one's communicative attempts, and the act of handing a picture to a listener is a basic form of interaction with another person. Bondy and Frost attribute this feature of the program to be a major reason for the success of the PECS. Even though Bondy and Frost's (1993) report is descriptive in nature, programs such as these offer new and promising directions to the incorporation of prerequisite skills in communication programs.

A Reexamination of Prerequisites for Success with Communication Systems

Within the broad category of persons said to have developmental disabilities, there is great variation among individuals in terms of the skills and abilities each brings to the learning situation. Romski and Sevcik (1988) have observed that individuals with severe intellectual impairments are typically more dissimilar than similar, and may also have additional disabilities including sensory or motor impairments. The consequence of this variation can be seen in the results of a number of studies which have been reviewed in this paper.

There now appears to be a growing interest in reexamining the role of prerequisite skills in the acquisition of communication systems. For instance, Romski and Sevcik (1988) and Sevcik et al. (1991) recommended that the choice of an appropriate sign or symbol system should be based on skills that each learner brings to the task. Instead of being guided by general assumptions, practitioners can evaluate the skills that learners possess and match these to the requirements of a particular system.

A Stimulus Equivalence Model

A clearer direction for practitioners to follow when planning a communication training program may be found by applying a stimulus equivalence model. As explained by Mackay (1991), stimulus equivalence research provides the basis for development of a technology to establish generative behavioral repertoires. By assessing the stimulus relationships that are prerequisite for new relations to develop, the conditions necessary for training a generalized verbal repertoire can be more easily established. This framework has much relevance when teaching verbal behavior to persons with developmental disabilities. Many developmentally disabled persons demonstrate the ability to acquire verbal behavior that is directly trained, yet transfer of stimulus control across verbal operants often does not occur. Therefore, the verbal operants that are trained do not necessarily contribute to

the development of a generalized verbal repertoire.

The distinction between behaviors that are directly trained and behaviors which facilitate the emergence of other relations has been explored by several authors. Alessi (1987) explained how strategies for teaching minimal repertoires have been successful in the teaching of abstract stimulus control, reading skills, and manipulative autoclitic frames. Hall and Chase (1991) discussed how verbal behavior can be analyzed within a stimulus equivalence paradigm. These authors proposed that a stimulus equivalence model can be used to analyze the development of generalized verbal relations, thereby defining the prerequisites necessary for acquisition of further behaviors.

Several investigators have already used a stimulus equivalence paradigm in the manner recommended by Hall and Chase (1991). Goodman and Remington (1991) used an equivalence paradigm to analyze how transfer of stimulus control can occur from the tact to mand relation and vice versa. Light, Remington, Clarke, and Watson (1989) discussed the possible equivalence classes that can occur in topography-based training when paired presentations of pictures and picture names are used. Their analysis is very useful, as it describes the prerequisite skills, or relations that must be present before new relations can emerge through training. In a related series of studies, Remington and Clarke (1993a, 1993b) used a stimulus equivalence paradigm to analyze why some students do not acquire additional equivalence relations when total communication is used. The pairing of speech and sign in total communication often results in acquisition of a mand compliance repertoire without explicit training. Remington and Clarke explain that students who do not develop this repertoire exhibit overselectivity to the visual modality, or in other words, the sign only. In these two studies, the effectiveness of several training procedures designed to overcome overselective attention are compared. Analyses such as these offer much promise in understanding how developmentally disabled persons acquire a verbal repertoire, and can lead to more effective training procedures which are tailored to the specific needs of individuals.

FURTHER DIRECTIONS FOR RESEARCH

The area of augmentative and alternative communication for persons with developmental disabilities is, happily, one that is has received a substantial amount of attention in recent years. Unfortunately, there seem to be many assumptions concerning the selection and design of communication systems which until recently, have gone unchallenged. In particular, the growing trend toward the recommendation of selection-based systems and away from topography-based systems was guided without a strong empirical basis. Now, there is a growing body of research and theory supporting the benefits of topography-based systems. Given the potential difficulties an individual may have in acquiring functional use of a selection-based system, topography-based verbal behavior appears to be easier to acquire and has less potential problems of a practical nature. The recent interest in directly comparing the two types of verbal behavior is encouraging and will hopefully result in further research of this type. Comparisons between topography-based and stimulus-selection based verbal behavior should consider the ease of equivalence class formation, and include a detailed description of communication skills that the learner possesses, classified in terms of Skinner's (1957) verbal operants. Additionally, research should consider issues of maintenance and generalization, to determine whether differences exist between topography-based and selection-based systems.

Many questions concerning the most optimum choice of a communication system for an individual remain to be answered. Clearly, a number of skills have been identified that influence successful acquisition of a generalized language repertoire, although there is still a great deal to be known regarding the relative

contribution of each skill and the way in which they enter into the formation of equivalences. The relevance of behaviors classified as preverbal communication to the acquisition of augmentative and alternative communication systems also needs clarification. Additionally, despite a growing body of research concerning the teaching of Skinner's (1957) verbal operants to developmentally disabled persons, an optimum sequence with which to introduce training in each of the verbal operants remains to be identified. As Sundberg (1991) observed, most communication training with developmentally disabled individuals has focused on receptive and tact training, with more emphasis needed on mand and intraverbal training. And finally, the area of multi-modal communication deserves much more consideration. Research should consider, among other questions, the skills that individuals need in order to benefit from a multi-modal system, and whether teaching multi-modal communication systems can actually facilitate the formation of equivalences. Research on the above topics could further clarify the behaviors that are likely to lead to success with a communication system, thereby offering a more effective way to make treatment decisions. This knowledge will ensure that all individuals receive the most appropriate training given the behaviors that they possess, and most importantly, will facilitate the acquisition of a generalized language repertoire in the most effective manner.

REFERENCES

Alessi, G. (1987). Generative strategies and teaching for generalization. *The Analysis of Verbal Behavior, 5,* 15-27.

Alwell, M., Hunt, P., Goetz, L., & Sailor, W. (1989). Teaching generalized communicative behavior within interrupted behavior chain contexts. *Journal of the Association for Persons With Severe Handicaps, 14 (2),* 91-100.

Beukelman, D. (1987). When you have a hammer, everything looks like a nail. *Augmentative and Alternative Communication, 3,* 94-96.

Bondy, A. S., & Frost, L. A. (1993). Mands across the water: A report on the application of the picture-exchange communication system in Peru. *The Behavior Analyst, 16,* 123-128.

Burke, J. C. (1991). Some developmental implications of a disturbance in responding to complex environmental stimuli. *American Journal of Mental Retardation, 96,* 37-52.

Butterfield, N. (1991). Assessment of preverbal communicative abilities in students with severe intellectual disability. *Australia and New Zealand Journal of Developmental Disabilities, 17* (4), 347-364.

Calculator, S. N. (1988). Teaching functional communication skills to nonspeaking adults with mental retardation. In S. N. Calculator & J. L. Bedrosian (Eds.), *Communication assessment and intervention for adults with mental retardation* (pp. 309-333). Boston: College-Hill Press.

Clarke, S., Remington, B., & Light, P. (1988). The role of referential speech in sign learning by mentally retarded children: A comparison of total communication and sign-alone training. *Journal of Applied Behavior Analysis, 21,* 419-426.

Cook, A. R., Anderson, N., & Rincover, A. (1982). Stimulus overselectivity and stimulus control: Problems and strategies. In R. L. Koegel, A. Rincover, & A. L. Egel (Eds.), *Educating and understanding autistic children* (pp. 90-105). San Diego: College-Hill Press.

Dennis, R., Reichle, J., Williams, W., & Vogelsberg, R. T. (1982). Motoric factors influencing the selection of vocabulary for sign production programs. *Journal of the Association for Persons With Severe Handicaps, 7,* 20-32.

De Paul, R., & Yoder, D. E. (1986). Iconicity in manual sign systems for the augmentative communication user: Is that all there is? *Augmentative and Alternative Communication, 2,* 1-10.

Dixon, L. S. (1981). A functional analysis of photo-object matching skills of severely retarded adolescents. *Journal of Applied Behavior Analysis, 14,* 465-478.

Doherty, J. E. (1985). The effects of sign characteristics on sign acquisition and retention: An integrative review of the literature. *Augmentative and Alternative Communication, 1,* 108-121.

Duker, P., & Remington, B. (1991). Manual sign-based communication for individuals with severe or profound mental handicap. In B. Remington (Ed.), *The challenge of severe mental handicap* (pp. 168-187). Chichester: Wiley & Sons.

Eikeseth, S., & Smith, T. (1992). The development of functional and equivalence classes in high-functioning autistic children: The role of naming. *Journal of the Experimental Analysis of Behavior, 58,* 123-133.

Goodman, J., & Remington, B. (1991). Teaching communicative signing: Labelling, requesting, and transfer of function. In B. Remington (Ed.), *The challenge of severe mental handicap* (pp. 215-234). Chichester: Wiley & Sons.

Green, G., Mackay, H. A., McIlvane, W. J., Saunders, R. R., & Soraci, S. A. (1990). Perspectives on relational learning in mental retardation. *American Journal on Mental Retardation, 95 (3),* 249-259.

Hall, G. A., & Chase, P. N. (1991). The relationship between stimulus equivalence and verbal behavior. *The Analysis of Verbal Behavior, 9,* 107-119.

Hall, G. A., & Sundberg, M. L. (1987). Teaching mands by manipulating conditioned establishing operations. *The Analysis of Verbal Behavior, 5,* 41-53.

Halle, J. (1988). Adopting the natural environment as the context of training. In S. N. Calculator & J. L. Bedrosian (Eds.), *Communication assessment and intervention for adults with mental retardation* (pp. 155-185). Boston: Little, Brown, & Co.

Hodges, P., & Schwethelm, B. (1984). A comparison of the effectiveness of graphic symbol and manual sign training with profoundly retarded children. *Applied Psycholinguistics, 5,* 223-253.

Hooper, J., Connell, T. M., & Flett, P. J. (1987). Blissymbols and manual signs: A multimodal approach to intervention in a case of multiple disability. *Augmentative and Alternative Communication, 3,* 68-76.

Hurlbut, B. I., Iwata, B. A., & Green, J. D. (1982). Nonvocal language acquisition in adolescents with severe physical disabilities: Blissymbol versus iconic stimulus formats. *Journal of Applied Behavior Analysis, 15,* 241-258.

Kangas, K. A., & Lloyd, L. L. (1988). Early cognitive skills as prerequisites to augmentative and alternative communication use: What are we waiting for? *Augmentative and Alternative Communication, 4,* 211-221.

Keogh, W., & Reichle, J. (1985). Communication intervention for the "difficult to teach" severely handicapped. In: S. Warren & A. Rogers-Warren (Eds.), *Teaching functional language* (pp. 157-196). Baltimore: University Park Press.

Kouri, T. (1989). How manual sign acquisition relates to the development of spoken language: A case study. *Language, Speech, and Hearing Services in Schools, 20,* 50-62.

Lamarre, J., & Holland, J. G. (1985). The functional independence of mands and tacts. *Journal of the Experimental Analysis of Behavior, 43,* 5-19.

Lazar, R. M., Davis-Lang, D., & Sanchez, L. (1984). The formation of visual stimulus equivalence in children. *Journal of the Experimental Analysis of Behavior, 41,* 251-266.

Light, J. (1988). Interaction involving individuals using augmentative and alternative communication systems: State of the art and future directions. *Augmentative and Alternative Communication, 4,* 66-82.

Light, P., Remington, B., Clarke, S., & Watson, J. (1989). Signs of language? In: M. Beveredge, G. Conti-Ramsden, & I. Leuder (Eds.), *Language and communication in mentally handicapped people* (pp. 57-79). London: Chapman & Hall.

Locke, P. A., & Mirenda, P. (1988). A computer-supported communication approach for a child with severe communication, visual, and cognitive impairments: A case study. *Augmentative and Alternative Communication, 4,* 15-22.

Lowenkron, B. (1988). Generalization of delayed identity matching in retarded children. *Journal of the Experimental Analysis of Behavior, 42,* 1-18.

Lowenkron, B. (1991). Joint control and the generalization of selection-based verbal behavior. *The Analysis of Verbal Behavior, 9,* 121-126.

Mackay, H. A. (1991). Stimulus equivalence: Implications for the development of adaptive behavior. In: B. Remington (Ed.), *The challenge of severe mental handicap* (pp. 235-259). Chichester: Wiley & Sons.

McEwen, I. R., & Lloyd, L. L. (1990). Some considerations about the motor requirements of manual signs. *Augmentative and Alternative Communication, 6,* 207-216.

McIlvane, W. J., Dube, W., Klederas, J. B., Iennaco, F. M., & Stoddard, L. T. (1990). Teaching relational discrimination to individuals with mental retardation: Some problems and possible solutions. *American Journal on Mental Retardation, 95 (3),* 283-296.

Michael, J. (1985). Two kinds of verbal behavior plus a possible third. *The Analysis of Verbal Behavior, 3,* 2-5.

Michael, J. (1988). Establishing operations and the mand. *The Analysis of Verbal Behavior, 6,* 3-9.

Michael, J. (1993). Establishing operations. *The Behavior Analyst, 16,* 191-206.

Mirenda, P. (1985). Designing pictorial communication systems for physically able-bodied students with severe handicaps. *Augmentative and Alternative Communication, 1,* 58-64.

Mirenda, P., & Dattilo, J. (1987). Instructional techniques in alternative communication for students with severe intellectual handicaps. *Augmentative and Alternative Communication, 3,* 143-152.

Mirenda, P., & Santogrossi, J. (1985). A prompt-free strategy to teach pictorial communication system use. *Augmentative and Alternative Communication, 1,* 143-150.

Ogletree, B. T., Wetherby, A. M., & Westling, D. L. (1992). Profile of the prelinguistic intentional communicative behaviors of children with profound mental retardation. *American Journal on Mental Retardation, 97 (2),* 186-196.

Owens, R. E., & House, L. I. (1984). Decision-making processes in augmentative communication. *Journal of Speech and Hearing Disorders, 49,* 18-25.

Reichle, J., Mirenda, P., Locke, P., Piché, L., & Johnston, S. (1992). Beginning augmentative communication systems. In S. F. Warren & J. Reichle (Eds.), *Causes and effects in communication and language intervention* (pp. 131-156). Baltimore: Paul H. Brookes.

Reichle, J., Sigafoos, J., & Remington, B. (1991). Beginning an augmentative communication system with individuals who have severe disabilities. In B. Remington (Ed.), *The challenge of severe mental handicap* (pp. 189-213). Chichester: Wiley & Sons.

Remington, B., & Clarke, S. (1993a). Simultaneous communication and speech comprehension. Part I: Comparison of two methods of teaching expressive signing and speech comprehension skills. *Augmentative and Alternative Communication, 9,* 36-48.

Remington, B., & Clarke, S. (1993b). Simultaneous communication and speech comprehension. Part II: Comparison of two methods of overcoming selective attention during expressive sign training. *Augmentative and Alternative Communication, 9,* 49-60.

Romer, L. T., & Schoenberg, B. (1991). Increasing requests made by people with developmental disabilities and deaf-blindness through the use of behavior interruption strategies. *Education and Training in Mental Retardation, 2,* 70-78.

Romski, M. A., & Sevcik, R. A. (1988). Augmentative and alternative communication systems: Considerations for individuals with severe intellectual disabilities. *Augmentative and Alternative Communication, 4,* 83-93.

Romski, M. A., Sevcik, R. A., & Pate, J. L. (1988). Establishment of symbolic communication in persons with severe retardation. *Journal of Speech and Hearing Disorders, 53,* 94-107.

Rotholz, D. A., Berkowitz, S. F., & Burberry, J. (1989). Functionality of two modes of communication in the community by students with developmental disabilities: A comparison of signing and communication books. *Journal of the Association for Persons with Severe Handicaps, 14 (3),* 227-233.

Rowland, C., & Stremel-Campbell, K. (1987). Share and share alike: Conventional gestures to emergent language for learners with sensory impairments. In: L. Goetz, D. Guess, & K. Stremel-Campbell (Eds.), *Innovative program design for individuals with dual sensory impairments* (pp. 49-75). Baltimore: Paul H. Brookes.

Saunders, K. J., & Spradlin, J. E. (1989). Conditional discrimination in mentally retarded adults: The effect of training the component simple discriminations. *Journal of the Experimental Analysis of Behavior, 52*, 1-12.

Saunders, K. J., & Spradlin, J. E. (1990). Conditional discrimination in mentally retarded adults: The development of generalized skills. *Journal of the Experimental Analysis of Behavior, 54*, 239-250.

Sevcik, R. A., & Romski, M. A. (1986). Representational matching skills of persons with severe retardation. *Augmentative and Alternative Communication, 2*, 160-164.

Sevcik, R. A., Romski, M. A., & Wilkinson, K. (1991). Roles of graphic symbols in the language acquisition process for persons with severe cognitive disabilities. *Augmentative and Alternative Communication, 7*, 161-170.

Sidman, M., Willson-Morris, M., & Kirk, B. (1986). Matching-to-sample procedures and the development of equivalence relations: The role of naming. *Analysis and Intervention in Developmental Disabilities, 6*, 1-19.

Siegel-Causey, E., & Guess, D. (1989). *Enhancing nonsymbolic communication interactions among learners with severe disabilities*. Baltimore: Paul H. Brookes.

Skinner, B. F. (1957). *Verbal behavior*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Stromer, R., McIlvane, W. J., Dube, W. V., & Mackay, H. A. (1993). Assessing control by elements of complex stimuli in delayed matching to sample. *Journal of the Experimental Analysis of Behavior, 59*, 83-102.

Sundberg, C. T., & Sundberg, M. L. (1990). Comparing topography-based verbal behavior with stimulus selection-based verbal behavior. *The Analysis of Verbal Behavior, 8*, 31-41.

Sundberg, M. L. (1990). *Teaching verbal behavior to the developmentally disabled*. Pleasant Hill, CA: Behavior Analysts, Inc.

Sundberg, M. L. (1991). 301 research topics from Skinner's book *Verbal Behavior*. *The Analysis of Verbal Behavior, 9*, 81-96.

Sundberg, M. L. (1993). The application of establishing operations. *The Behavior Analyst, 16*, 211-214.

Wraikat, R., Sundberg, C. T., & Michael, J. (1991). Topography-based and selection-based verbal behavior: A further comparison. *The Analysis of Verbal Behavior, 9*, 1-17.

Yoder, P. J., & Layton, T. L. (1988). Speech following sign language training in autistic children with minimal verbal language. *Journal of Autism and Developmental Disorders, 18 (2)*, 217-229.

Zygmont, D. M., Lazar, R. M., Dube, W. V., & McIlvane, W. J. (1992). Teaching arbitrary matching via sample stimulus-control shaping to young children and mentally retarded individuals: A methodological note. *Journal of the Experimental Analysis of Behavior, 57*, 109-117.